Near Wellbore Mechanics

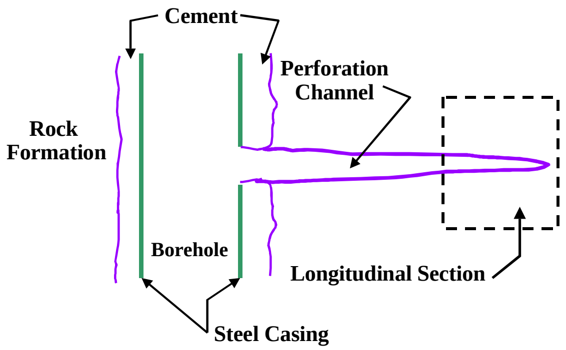
Need

Sand production from oil wells occurs when the well fluid being produced and carried into the well dislodges a portion of the formation solids. Typically the formation from which fluid is being produced is sandstone and the solids coming out with the fluid is sand, though solids can be produced from a variety of formation types. Sand in the well fluid can erode casing, pipes and pumps or plug the well if sufficient quantities are produced. Removal of formation solids increases the size of the wellbore to the point that collapse can occur cutting off the well from oil producing zones beneath. Oil companies spend a significant amount of money each year to control sand production. They do this by installing gravel-pack or screen filters to catch the sand as it enters the well. All sand production control methods currently in use reduce the flow of oil in the well and cut production. Oil companies desire to have a predictive capability that will allow them to produce a well at a flow-rate just below that which will produce sand.

Description

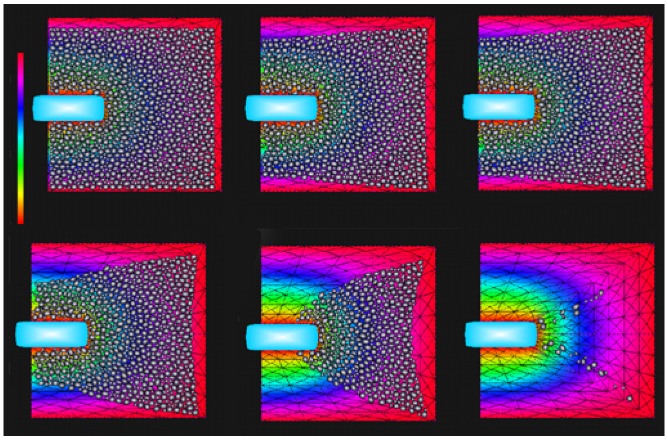
The Geomechanics Department of Sandia National Laboratories is developing computational techniques to predict the onset and rate of sand production. Discrete element methods (DEM) coupled with computational fluid flow techniques are being developed to model and predict sand production behavior. This research and development work is being done through cooperation between Sandia and the Massachusettes Institute of Technology (MIT). The 2-D coupled discrete-element/fluid- flow code is called MIMES. Capabilities of the MIMES code are discussed in more detail in the section on Discrete Element Modeling. Development of these capabilities has been accomplished under a DOE program called ACTI (Advanced Computational Technology Initiative). The ACTI program is designed to apply National Laboratories computational mechanics capabilities to oil industry problems. This particular project has eleven oil industry partners that joined the project and signed the governing agreement. As oil company problems are solved it is expected that the computational methods will mature and provide even more capability for solving problems related to Defense Program projects. This code will be transferred to oil company partners this year and will also be applied to significant problems in defense programs.

Oil Well and Perforation Channel



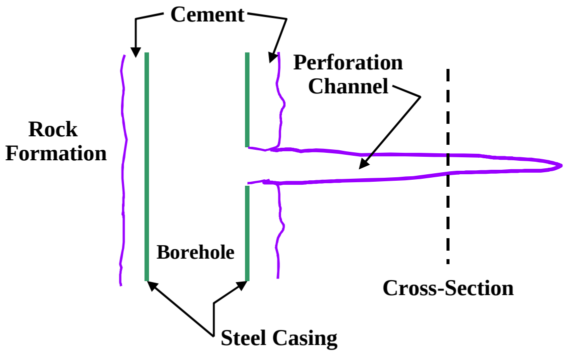
A perforation channel cut through the steel casing, cement and rock formation by an explosive shaped charge. A sand production simulation has been performed on a longitudinal section (side view) at the end of the perforation channel.

Illustrated below is a perforation channel radiating out from an oil well. Perforation channels are created by explosive shaped charges that punch a hole in the steel well casing, cement and rock formation. Perforations allow fluids to flow from the rock formation into the wellbore. At the end of the perforation channel is the location of a sand production simulation on a longitudinal section along the perforation channel.

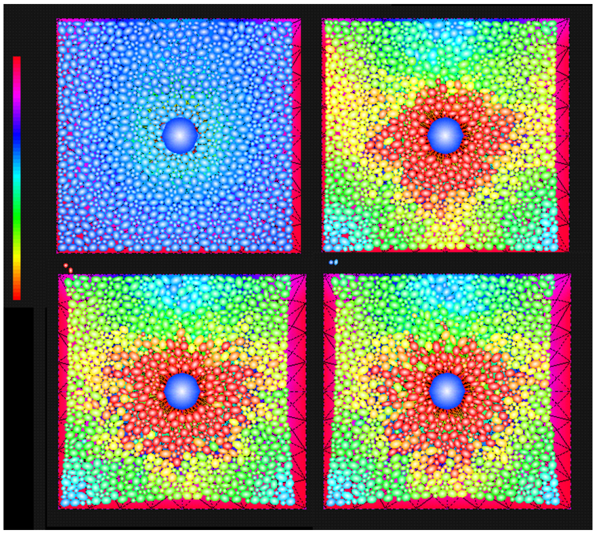


Progressive sand production simulation along a longitudinal section (side-view) of a perforation channel in an oil well. The colored background represents the fluid flow computation grid where the pressure is higher around the outside edges of the grid and lower adjacent to the perforation channel (shown in blue). The particles represent sand grains in a sandstone formation. The sand particles are pulled into the perforation by the fluid flow.

Oil Well and Perforation Channel



Sand production simulation on a perpendicular cross-section through a perforation channel.



Sand production simulation on a perpendicular cross-section through a perforation channel. The fluid flow grid is in the background and colored to represent fluid pressure. Coloring of the particles represents the velocity of the particles with red being the highest and blue the lowest. Sand particles are being pulled into the perforation channel in the middle by the difference in fluid pressure between the perforation channel and the outer boundary of the fluid grid. Particle velocity, as indicated by color, is highest near the perforation channel.

References:

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